DOCUMENT RESUME

ED 237 928 CS 007 209

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TITLE Biocybernetic Approach to the Analysis of a Literary Text.
PUB DATE Feb 83
NOTE 57p.
PUB TYPE Viewpoints (120) -- Information Analyses (070)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Aesthetic Education; Cerebral Dominance; *Cognitive Processes; Interdisciplinary Approach; Learning Theories; *Literary Criticism; Perception; Psychophysiology; *Reader Response; *Reading Strategies; Research Methodology
IDENTIFIERS Aesthetics; *Biocybernetics; Biometrics

ABSTRACT

Presented as a contribution to the discussion on aesthetic stimulation, the role of imagination, and the identity of specific aesthetic stimuli and their relative intensity within a given microcontext, this paper proposes the application of biometric tests to monitor readers' physiological responses to selected literary texts as a precedent for collaboration between biometric research and aesthetically oriented literary criticism. The three sections of the paper deal with the following topics: (1) the biocybernetic approach to the information impact of a literary text, (2) aesthetic stimulations of a literary text from the biocybernetic viewpoint, and (3) the instrumentation and methodology of biocybernetic assessment. An extensive bibliography concludes the paper. (FL)

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Biocybernetic Approach to the Analysis of a Literary Text

February 1983

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A new area of research. Biometric tests applied to monitor the reader's physiological responses to selected literary texts. The information impact of literary texts on the human mind. The literary text from the cybernetic point of view — an information cascade. The individual perception of literary text. The reader's historical conditioning. The human brain and physiology of reading and perceiving. Memory and its properties. Perceptual stereotypes, the genesis of symbols. The skill of distinguishing between literary subjets and their stylization is not a natural perceptual disposition but a result of theoretical training.

Man's elementary perception does not distinguish between "esthetic" and "non-esthetic" information. The knowledge and speculations on the physiology of esthetic surprise. Individual conditioning of esthetic response. Esthetic information profile of literary text. Present stage of biometric tests. Recording the oscillations of the reader's esthetic experience.

CONTENT

1. Biocybernetic Approach to the Information Impact of a Literary Text ..... Page 1

2. Esthetic Stimulations of a Literary Text from the Biocybernetic point of view ..... Page 23

3. Esthetic Information Profile of Literary Text; instrumentation and methodology of biocyberntic assessment ..... Page 35

4. Bibliography ..... Page 51

I. THE BIOCYBERNETIC APPROACH TO THE INFORMATION IMPACT OF LITERARY TEXTS

The first scientific attempts to explore individual psychophysiological responses triggered by literature have begun in the United States, Russia, Japan, Germany and Canada. So far, we are only aware of a few methodologies; new equipment and techniques continue to be developed. As a result of this research, esthetics may gradually become a meeting ground of humanism and science.

At the present stage of the biometric methods, it would be absurd to assume that one can measure the reader's esthetic joy the same way one can take his temperature when he is sick. But any extension of knowledge on how and when the information from a book enters the human brain, if and when it starts to be processed (enjoyed) and later possibly memorized is a valuable investigation of humanist values reflected in literature, such as "beauty", "joy", "love", or "freedom", values which we may share and treasure as the ultimate goals of our life.

The subsequent account of biometric measurement of the responses to texts first analyzed is one of the first precedents of future collaboration between biometric research and esthetically oriented literary cirticism. It forms a relevant appendix to the discussion on esthetic stimulation, on the role of imagination, on the identify of specific esthetic stimuli and on their relative intensity within a given microcontext.

The method of tracing the reader's responses to esthetic texts consists of a series of biometric laboratory tests. They do not follow the exact order and hiearchy of the values and categories of literary criticism, simply because some of these are not the same when we enter the area of the human brain. The recorded responses to identifiable esthetic stimuli in the text, both stylistic and contentual, cannot be categorized and assessed as specifically as the humanist categorized them in the comments on the discernible elements of his own esthetic delectation. At this phase of research, biometric science can register the energy oscillations which occur in the moment when the person tested reads a specific work or specific sentence in a given text. The resulting graph could also remotely indicate if the specific swing recording a specific energy change is a result of erotic, supernatural or prosodic stimulation or of pleasure derived from the grammar of the statement. We all may share an understanding of intanglibles such as courage or justice, but the appearances, intensities and even the mechanism of retrieval of these abstract concepts differ with every individual.

The only conclusion one can draw is that a textual allusion to such notions enters the reader's brain where it elicits a reaction in the moment of its entry. These changes carry a potential evidence of esthetic delectation. To monitor the reader's responses to literary texts, five basic biometric

tests have been applied so far, administered in the following order:

1. General Readability Test (GRT), assessing input of information in the reader's brain. This investigates whether the text is fully or partially intercepted by the eye and carried into the visual cortex of the brain as chemo-electrical potential.

2. Decision/Selection Test (DS), locating the possible "domains", or parts of the text which are carried into the brain with higher or preferential intensity of signal--and, in the negative sense, the parts of the text which are overlooked missed or skimmed over by the reader.

3. Formal Test Group (ST, MT, CT), assessing possible specific impact of printed media, taking into acount the form, time and environment of the reading process.

4. Stress Wave Test (SWT), assessing possible beginning and development of the stress wave in the brain's cortex which is loosely connected to the term "emotions", "emotional thinking".

5. Retrieval Test (RT), investigating the parts of text which are easily or preferentially retrieved from the memory of the reader.

So far, it is not practical to record responses to long integral texts such as novels or plays. Short texts such as well known poems or fragments of prose, which relate, e.g., a significant event, conflict, or comical, erotic, bizarre, supernatural adventure are best samples whose esthetic density would be assessed either relatively high or relatively low.

People of different sexes and of different ages and nationalities, with varying linguistic competence and education, when tested biometrically, show great differences in the perception, enjoyment and retention of the texts--far more than we may attribute to differences in backgrounds or competencies.

Furthermore, the isolation of "pure" esthetic impact is inhibited by the fact that nearly each person had a different conception of the term "esthetic". Therefore, the following text will outline at least four basic approaches to the esthetic as understood by the readers. Perhaps due to the subjective concept of esthetic values, the same text read and understood by several readers produces very different retrival/memory/responses. As all readers have different memory characteristics, they also acquire different esthetic priorities, which are influenced by their memory.

Before outlining the main features of biometric tests and before interpreting their results, it may be helpful--especially from the point of view of the lay reader--to discuss their general criteria. The most important among these criteria are the concept of text from the point of view of biometric measurements, the perception of the textual stimuli by the brain, and the biometric response to the transmitted literary material.

transmitted literary material.

In his attempt to analyze the esthetic information impact produced by literary texts, it will be useful to apply current discoveries in the disciplines of biocybernetics, system and information theories, neuro- and psychophysiology. The experimental techniques were used to record the measurable information input and esthetic impact of literary texts. Using the results of these tests the researcher attempted to draw an esthetic information profile of a specific literary text.

Any literary text may be seen here as a matrix of coded sensory stimuli, which are catalysts for subsequent activity in the cortical and subcortical regions of the human brain. The anatomy and physiology pattern of the human cortex permit very versatile simultaneous decoding, processing and storage of the same literary text and can cause broadly ramified reflections, influence the reader's behavior, store information and retrieve memories from his brain.

The current investigation of the esthetic information impact by various experimental psychological methodologies seems to be unsatisfactory. Any question asked, any verbal or graphical record retrieved from the reader, is full of biases, especially during the retrieval period when the nature of the question, interviewer, interviewing situation, and many other factors alter the original esthetic information impact of the text. Moreover, the information already stored in the reader's brain greatly influences the text's impact. The research indicates that in a very few seconds of time, the

incoming information from the text merges in a sea of other impulses, activities and processes not connected with the text. The result is always cumulative.

At the level of the brain's cortex, words, sentences or literary texts really do not exist as entities. Thanks to our inborn and accumulated abilities, the human brain encodes and decodes the verbal text into larger information clusters--patterns and matrixes which sometimes correspond to whole situations, actions, chapters or a whole book. A writer's artistry helps to shape such a pattern, yet it is very difficult either for the writer or the layman to visualize it because it has chiefly electro-chemical characteristics referred to as the temporal neural pathway. In literary terms this pathway is the physiological record of the formal or contentual impact of the text. This record is usually fixed in the borders of the neural pathways. The borders of neural pathways are the source of the reader's mental reactions which we call "esthetic" feelings, appreciation, value judgements. In the reader's mind as in the text, both the content (carrier) and form of literary work are closely parallel.

The methodology of the experimental research described here is largely neurophysiological. It is called "biometric" because what is measured are variations of energy states in parts of the human body, namely in the brain. This corresponds to the basic notion of information as an energy reaction. It is much more precise to measure the impact of a text by electrodes than by asking a reader a question. But at this stage of research, it is much more difficult to interpret

the biometric data than the reader's opinion on whether he "likes" or "dislikes" a particular feature of a literary text; whether he is enlightened or thoroughly bored. It also is difficult in biometry to generalize the findings extracted from many readers. In terms of the brain we are as different from one another as are the species of the animal world. Yet we read books and understand them commonly and can communicate about them. Let's examine how, within what frame and with which kinds of biases or educated guesses, such processes happen.

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From the biometric point of view, information contained in any literary text consists only of those distinguishable parts of the text which cause neural energy changes with catalytic characteristics. Memorized, stored cognitive content cannot be conceived as information. In our life, information does not exist in isolation, but moves within specific channels, called information chains, matrixes and patterns. In a simple scheme, every information chain has three components: information source (text, book, performed speech); transmission conditions (place and time in which a text is read, heard or otherwise perceived) and the receiver and his responses (readers and their corresponding states of mind vis-à-vis the materials read).

If any part of the information chain is changed, the information itself is slightly or considerably changed. For a long time it was believed that an information source in itself contained all the

esthetic information impact and nothing could change it. Writers and typographers invented countless aids to maximize the retention of words, including type selection, layout and supporting illustrations. Today we know that the text carries only a certain amount of information, the stimuli most capable of starting the catalytic process in the brain's cortex. Some literary texts have carefully designed stimuli, worked out by the writer up to the last possible detail; others count on the reader's free associations and still others involve the readers in psycho-dramatic ways. Generally, according to information system theory, texts may contain various degrees and quantities of functional (logistic), perceptual and stress characteristics, reflected in the reader's subsequent behavior--latent or pronounced.

Literary criticism often takes into account the degree of information contained in the text--both programmed, fiction (high degree of information at source), and formalist, stylistic or poetic literature (low degree of information at source, demand for a high degree of association from the reader). But very little has been done in the literary analysis of quantitative information measurements within literary texts.

Transmission conditions (time and space, how, when and where the book or text is read) were believed to be a passive process (not affecting impact), mostly involving the basic skills of literacy such as word recognition, grammatical understanding and perception of meaning. But when transmission of information occurs over a longer period of time,

this is only partly true. During a short reading time, content elements may prevail, during a longer time, formal ones. If perception of a piece of literature is dispersed widely over time or space (over various generations or in different cultural zones), the same text may have a different esthetic information impact.

Readers repeatedly exposed to similar contents or forms of literature very often form stylistic, cognitive or formal stereotypes or archetypes specific to cultures, centuries, or transmission media. But certain stereotyped or archetyped texts may not be understood in the same way by a reader of another culture or century.

The amount and the form of information perceived is not the same as in the information source itself. It may be, but in most cases is quite different. Usually, only a minor information quantity conveyed by the text is stored in the human memory. The brain of a skilled reader learns quickly to retain only minimal contextual or formal cues from the book or text read.

During the reading, other mental processes are catalyzed, memories retrieved, situations imagined, psychodramatically expeienced, etc. This constitutes the secondary information impact of the literary text. It can provoke the reader's response, either a latent one (i.e., contemplating the intrigue or character), or an overt one (talking about the text with friends, modelling one's own behavior after fictional characters and their actions). The receiver's response may also be an information source for another informatin chain (in the case of literary criticism, a review or analysis).

Information chains exist in a certain time and space. For each literary text, there is a production time, transmission time and perception time. Both production and perception time contain a high amount of meta-information processing (thoughts of the writer before the creation of the literary text; thoughts of the reader during and after reading the book). The transmission time is the actual reading time.

A literary text, like other works of art, may be viewed from a biocybernetic viewpoint as an information cascade, in which one piece of information after another is processed in dense succession. It is a horizontal type of information cascade. This cascade is typified by the perceiver's relative freedom in processing the successive information data at his own pace and with his own selectivity. The level of information programming in a literary text is higher than current levels in magazines or newspapers. The reader is expected to follow page after page, from the first chapter to the last, but nobody restricts him from skimming or skipping certain pages if he chooses.

Any time the reader interrupts the succession of words, the hierarchy of information just perceived undergoes changes--minor or substantial. This can enhance the esthetic information impact of the text in some cases, so that the mind of the reader works further on information reprocessing (e.g., dreaming about content, relating the text to his own memories or values, psychodramatic inclusion of reader into the book's story, etc.). Other interruptions may decrease the

text's impact. This happens when the reader turns away from the text and its subject to other topics or activities. Such diversions, however, may be beneficial, especially in the case of fatigue. Distraction provides a rest and replenishes energy in the cortex of the brain. The most disadvantageous interruptions of reading are those which occur when the flow of information from the text crosses another intense information flow, and both quanta compete in the cortex of the brain for simultaneous processing. The brain itself is capable of many simultaneous information flows in a fraction of a second, but input-output perepherics (senses, feedback, responses) are time-consuming and substantially decrease the chances that the prior information will be processed at all. Such interruptions range from very minute ones to those lasting several hours or days. Even a small detour or a fixed gaze in a different direction or dialogue exchanged while reading may change the information impact of the text. But if the interruption ends within the range of the short-term memory processing time (around 40 seconds), the original information flow can be restored quickly and without too much delay. With longer interruption it can take several minutes to reactivate the original information flow, and it is always fragmented and incomplete.

The important influence of information environment is indirect. In terms of pace, the reading of texts nowadays constitutes relatively leisurely information impact. Other information inputs occur with higher intensity and frequency: films, radio, and television programs;

car, train and air trips through landscapes and cities; the contemporary city itself, with its rich, fast-moving informational environment, multitude of shops and products observed within a short span of time. Today's prevailing mode of perception affects our reading technique, leading to information skimming. Even if the information is perceived fully, younger generations increasingly process such information only partially. This has less effect on contemporary literature because it tries to adjust with fast-paced stories, dramatic dialogues, or assimilation of filmscripts or TV situations into literary genres. On the other hand, someone reading an 18th century classic in the 20th century information processing mode, consciously or unconsciously may partially or totally misunderstand its content, style and specific esthetic values.

From ancient time all writers have practised the strategy of "reader's motivation"--devoting the introduction of their literary work to careful, artful familiarization of the reader with the author's own flow of thoughts, styles of thinking, characters and epical explanations. By force of this information process, an invisible bond links the reader and author, across centuries, generations, and cultures. This bond is strong whenever the intensity and frequency of the reader's informational environment is slower than inside the text; it is weak or impossible to establish when a high-intensity informational environment surrounds the reader, especially if the author insists on tightly programmed progressions of storage or styles.

Interesting geneological and histological phenomena affect the perception time of the information cascade found in texts. Every human being perceives the information and its esthetic aspects through slightly different routes and in a different manner. The young reader may read faster sequentially, but slower contextually; the mature reader may process information from a literary text very quickly and in great depth; the old person may slow down the reading pace, and pause more often for meta-information reprocessing (dreaming, resting). For ten or twelve centuries, the perceptual time changed little, but now the manner and speed with which we perceive information from our environment has changed greatly. In the contemporary world, especially in America or Europe, the speed of human information processing is the fastest our civilization has ever known. While this would not mean that all information man perceives from the environment is perceived and duly processed and stored (some authors may label this mode as a "shallow mind"), it does suggest that we are living more than one "biological informational" life. And perhaps this fact is one of the underlying reasons for what has been called the "generation gap."

The complex of all habits and approaches toward information interception, processing and storage can be called the information spectrum of the reader. This also varies with time and space. Human environment, culture, history (traditions), greatly influence the way people perceive the world. Similar environments, cultures, traditions can group and adjust individual information modes into a more or less

common way of intercepting, processing or storing information; these are called information stereotypes. If such a similar way of seeing things can be found in living or literary examples (in a situation, character, action), an information archetype emerges.

Sometimes, we deal (even in the same country) with a multi-layered public of readers--each layer with a different identification of content, time and place of information within the same literary text. The unity of text, content or style is undermined from the reader's side and the understanding of the text's content or style becomes less meaningful for people with different perceptual stereotypes. Sometimes opposite values are attached to the same content by different readers. When a reading public is widely diversified by culture, geographic region or era, the literary text may make its first impact on the reader via external formal features including layout, typographic impact. The average reader probably responds to the content of the text whereas the skilled reader may experience the esthetic information impact stemming from both content as well as from form of the text.

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In order to understand what happens during information interception, processing and storage, we have to be familiar with the basic components and functions of the human brain.

Sensory information is processed in the human body by the brain which is composed of approximately a hundred billion cells. These

cells are of two kinds: neurons, which are the functional units, and glia, which are filters of space but which have specific functions at certain times of brain activity. Each neuron has a cell body and connections called axons and dendrites (incoming and outgoing fibers). Between these bodies, and also between these connections, there are liquid gates called synapses in which the transfer of chemical and electrical activities are combined.

The number of neurons are more or less loosely interconnected. The electrochemical activity of such neurons is called a neuron circuit (which is of a temporary nature); it is the basic unit for information processing in the human brain. The interrelated activity of neuron circuits is what is commonly referred to as "thinking." During this procedure, more can happen than mere energy transfer: the chemical properties of the synaptic gates or neuron cell bodies are slightly changed. These changes, which are more or less permanent, are the basis of human memory. If the change occurs on the level of the synapsis or glia, a lower level of information unit can be stored. If, however, the change occurs in the cell bodies of a large area (a memory complex), then we store information patterns which, in turn, are capable of starting or influencing many future information transfers (ways of thinking). If the chemical change is durable and capable of influencing other parts of the brain on a similar level, then we are dealing with high stereotypes or skills. This process is close to our codes of "learning." If a whole structure of more or less permanent, interconnected neuron circuits is created, we label this feature the temporal neural

pathway, which is the basic means for the processing and storing of contentual information ("thought," "idea"). In response to this process the borderline of such pathways creates a resistance pattern which may direct future excitation or decay of the pathways themselves--our notion of "value."

A single neuron circuit is not capable of processing such complex notions as a "tree" or "house." Instead, a multitude of neuron circuits are in operation, not only at the very moment when a person sees a tree, but also shortly thereafter. The final fixation of memory is finished several hours after the moment of perception. If a person receives several information units during a short period of time, neuron circuits may start to anticipate additional information impact before the actual input is received. When several neuron circuits are activated, forming the sensory input, the inner feedback mechanism not only further specifies the sensory target (e.g., movement of the eye) but it also builds a very specific hierarchy of activities within the brain; therefore the perception process leaves certain neuron circuits with higher energy potential than others. Thus energy transfer is the transmission medium in the brain; it in turn is dependent on the sensitivity of the neuron circuits. The neuron circuits have a certain minimal energy level which can be increased or decreased metabolically or mentally. This "sensitivity" can also be changed due to the sensory input causing later chemical changes.

There are two principal mechanisms of neural transfer in the

human brain: 1) Specific transfer, in which energy transfer is determined by the intensity of the incoming energy and its characteristics (e.g., amplitude and time). This mechanism produces what is generally called "rational thinking," or "reasoning." This process is only faintly detectable on EEG records. 2) Wave transfer: with certain sensory or metabolic inputs, the large volume of incoming energy can act as a catalyst for an avalanche of activities in many neuron circuits, regardless of their thresholds, but dependent on the proximity of the cortical (and often also the subcortical) regions. In such cases, the person reports "emotions," or "feelings."

Although esthetic feelings involve both these types of transfer, the the combination alone does not constitute esthetic feelings. The processing, storage, and, especially, the reflection (feedback) of such processes back to the cortex make up the psychophysiological basis for "esthetic feeling," or, in special cases, what we term creativity, enlightenment, or even inspirational trance.

The combination of mechanisms does not occur often or easily Usually, when the cortex is in the state of wave transfer, the intensive specific transfer is subdued. On the other hand, if a person predominantly employs specific transfer (rational thinking), subcortical activities are subdued.

Certain persons may have an inclination to certain modes of transfer. There is a difference between the sexes: women produce wave transfers more easily, or employ more subcortical regions of the brain

during their lives. Men are commonly known to suffer earlier from deficiencies of specific transfers (senility) in old age. There are also certain differences in the combination of both mechanisms due to racial and cultural differences.

When input from sensors activates the neuron circuit, the information part is not only registered or retrieved, but something else remains in the human brain: any electrical activity slightly changes the substance made or reacted to by the cell. There are organic substances that are more susceptible to electrical activity than others. In certain chemical configurations, this transfer may occur quickly or slowly, or not at all. The basis of human memory is probably a chemical one. Human memory seen in time (time axis), bears energy characteristics.

Human memory is not limited to the brain. There are other cells in our body which are capable of "memorizing" (genetical, immunological memory, etc.). What is specific to brain memory is that the chemo-electrical retrieval is compressed at a very high quantity and speed--both of which are capable of changing the stored information to an unknown extent.

There are three levels of memory in the human brain and sensors alike. The first level is the primary sensory memory, or input memory: man has refined his sensors toward the results (oncoming signal) and not toward the input function. This memory is in action when the eye reads certain parts of a picture, a letter in printed work, one invisible frame of film.

The second level of memory is a short-term memory, or a primary capacity of neuron circuits. (This permits us to remember for instance, a telephone number just long enough to dial it.) Such memory does not extend further than a time of 20-40 seconds, but depending on our daily usage of this memory, the time-range or quantity of bits stored can be extended manifold. The higher, more permanent storage is long-term memory. This memory is registered within minutes or hours from the moment of input, but can still be easily erased or interrupted (electrically, chemo-therapeutically or psychoanalytically). The build-up of such memory largely depends on the chemical properties present in the brain and in the body at that time. There is another, "more-than-long-term" (contentual) memory (which builds in the brain), with features called temporal neural pathways. This regulates a person's attitudes, values, judgments, moral or ethical codes of thinking, and (occasionally) behavior.

The short-term memory is characterized by high electrical activity in the neuron circuit. The long-term memory shows up in electrical measurements only as a rhythmical (time) pattern.

There are three discernible perceptual rhythmical patterns.

1. The basic (metabolic) perceptual rhythm. The human neural system has periods of high operational sensitivity and periods where, due to the metabolic changes, its functions are slightly subdued.

2. The imposed perceptual rhythm. The previously mentioned basic rhythm can be modulated due to the imput of information from the information

source or environment.

3. The stress (oscillated) perceptual rhythm. When catalysts in a work of art create stress waves (emotional impacts), the perceptual rhythm may become irregular, with current irregularities during short periods. This creates a "bouncing" pattern, where the receiver fills the space with stimuli from his own imagination (meta-subliminal effect).

When the informational environment supplies many bits of information in a short time, the recipient begins to connect them, creating information patterns. Dialectically, the information pattern becomes of a new entity, which may have different content, form, and esthetic impact.

The information pattern, for instance, related to a country, to a car, to women, develops over a period of time. Gradually, while the pattern remains in the human memory, the specific parts of the pattern decay, leaving only the indispensable features of it. This simplified pattern is called a perceptual stereotype. For evolving such a stereotype, a minimal amount of distinguishing signs are necessary, and a minimal amount of energy in the cortical neural system is used for retrieval. Therefore, it becomes an easy and comfortable way of thinking and dealing with the informational environment. Hence the great preference for character stereotypes in literature, or stereotyped situation comedies in television. But in the same way, the percpetual stereotype becomes an important tool for the effectiveness of thinking and is often evoked by the artist. For

example, in oval stones we can distinguish a human face, in a tree a human form, in a black dot on the highway, an automobile. The perceptual stereotype is, of course, still far from an esthetic stereotype.

When many information patterns coexist in daily life, less individual content of their parts is perceived or stored in the memory. When several generations, living in the same period, share the same perceptual stereotypes (as for instance in our time), this process can be viewed as a shallowing of previous ideas, content, styles, themes. It also explains the impact of television as an artistic medium which permits an easy information pattern transfer along with the resistance to books, a medium with low information pattern transfer.

When the information pattern is successfully used for a long time in communication, it becomes a symbol, with its own distinct way of identification, fixation and perception.

From the neurophysiological point of view, the formal and contentual parts of information are not processed in the brain very differently or on different places of the cortex. Usually, the information input from sensors carries formal and contentual parameters simultaneously, and the division of such components may, or in many cases, may not happen.

It is a predominant function of the upper cortical regions to reprocess incoming signals from the cerebellum (sometimes at too high a speed to be labelled real "feedback") before the first memory storages occur. This reprocessing enables the trained recipient to

differentiate between the "form" and "content" of a literary statement. Even the very highly developed brain may often have difficulty drawing such distinctions without training in esthetic analysis. Repeated sensory input closely followed by abstract evaluation may be needed to separate the stimulations of form and content of literary texts. Usually, analysis of literary subjects may be a simpler task than the identification and assessment of style. There are no specific direct leads in the information input which would encourage the recipient to distinguish formal and contentual qualities in the work of art. Formal instruction and theoretical education are therefore indispensable to reach this higher level of perception.

II

ESTHETIC STIMULATIONS OF LITERARY TEXT FROM THE BIOCYBERNETIC POINT OF VIEW

The previous discussion on specific physiological avenues of perception leads logically to biocybernetic speculations on the esthetic stimulation created by the perception of art in general and literature in particular.

Biocybernetists and neurophysiologists shy away from defining esthetics. Their natural precaution derives from the fact that what is easily labelled in one word (although we may differ in opinion in what this word means), is a complicated process in the human brain. In some cases it may coincide with conventional connotations of the term esthetics--but in other cases the physiology of esthetic enjoyment is hardly related to any esthetic theories and doctrines, and has connections with other mental or metabolic processes.

Here are some phases of the mental process on which we may base the biocybernetic concept of esthetic experience.

1. There is no significant distinction on the sensory level of

incoming information between "esthetic" and "non-esthetic" information. Eyes scan an artist's canvas or the parts of a machine in a similar mode at first. Ears hear both an unpleasant sound and a harmonic chord in the same way. This similarity extends only to the microsecond range. Very early, by the repeated process of looking at the picture or reading the text, or hearing the sound, the recipient's perception triggers a number of different feedback searches characterizing the perception of the work of art. The main feature of this process is its binary nature.

2. Recent research shows that there is little difference in the activity of the cerebral cortex when incoming signals from sensors are first processed in the brain. The cerebral cortex feeds back only the major physiological parameters of art (spectral changes of sound, color, geometry of space, contrasts in brightness and graphical characteristics of the text and the spaced information within a paragraph or on a page). But here the artist has the first chance of influencing the presentation of the artistic content. The sequence and timing of the information coming into the brain is dictated by the composition of a picture or a piece of music, by the syntax and formal arrangement of a literary statement. In this way the processing of information, the memory storage and abstract reflections can be significantly influenced. Most "formists" among estheticians pay attention to this part of the art perception process and describe the effect of formal esthetic qualities on the human mind in great detail.

But its actual impact extends far beyond the cerebral cortex and its function.

3. The processing of artistic factors varies significantly from the processing of functional information components. At first, there is usually a rich combination of stress-wave and specific transfers. This combination may have a different time base and space configurations in the cortex. It may start a) as stress-waves on the cortical level and fire specifically in the subcortical region (sometimes evoking motor responses, like laughter, blushing, movement of head, eyes, etc.); b) it may originate in the subcortical region and reach the cortical region with great delay when the art incorporates external reality and the recipient has more to respond to. Such, for instance, would be the case with a work of architecture, landscape or dance; c) it may be processed for a relatively long time (several microseconds) exclusively on the specific firing base of the cortex and then from short-term memory, causing stress-waves in the cortical or subcortical regions.

Further, there is usually a high number of feedback searches: the person returns to the initial sensory input many more times than for the usual functional information processing (eyes scan a painting more times than a similar piece of reality, ears heighten the sensitivity to small spectral changes of a tune), and these feedbacks should usually yield new information. (If the observer is not getting enough information input from subsequent searches, he considers the work "dull" or "shallow.")

Finally, there is usually a subsequent high activity in non-related cortical regions especially when the first memory searches become apparent

on the EEG record. One may suspect that the recipient (reader) is complementing the perceptual input of a work of art with personal memories, experiences, comparisons.

Thus, although the final neural pathway ("idea," "art form") may be formed in certain parts of the brain's cortex, during the processing of information, other, unrelated parts of the brain are also active.

The notion that pictures are processed on the right and words on the left hemispheres of the brain is only partially true. We only know that words or speech must activate the left brain hemisphere, and whenever a picture with spacial components is perceived, the right hemisphere is surely active. The final fixations in memory can overlap in very different regions of the brain, and retrieval may not only employ the mentioned single hemisphere, but the whole brain's cortex.

4. The enjoyment which we call "esthetic" originates some time between the processing of information from the perceived work of art and long-term memory storage.

The processing of information in the cortex activates the incoming information as well as the inner part of the cortex, which is in a state of constant action (during waking hours). The reflection of the processed information from the work of art on a certain remaining part of the cortex triggers the "esthetic" response. Recent research shows that this "certain part" of the cortex is very often in the frontal area of the brain, parental lobe. At present neurologists speculate that the major function of the cortical area in the parental lobes is one of

combinatory thinking. (When one is involved in mathematical games, chess playing or counting, there are bursts of high activity in the cortical regions of parental lobes.) By the functional disruptions of this area (due to accidents), one may lose one's ability to judge or reason, also the ability to distinguish between "beautiful" and "ugly." However, let us not overestimate the still hypothetical location of "esthetic" functions on the brain's cortex. In any case, the parental lobe region is only one element among other factors active in discerning qualities in art and their esthetic values. Without prior processing or specific input, the speculative action of the parental lobe may have no esthetic character.

Basically, this part of the neural process is similar to rational abstract thinking, but works with neural energy material of a different character (especially fusions of stress-waves and specific firings of neuron circuits). This is the reason why "esthetics" is sometimes labelled the "science of art" or the "science of beauty."

5. There is a certain by-product of "esthetic acknowledgement" of the stored information in long-term memory. When information is stored (chemically), there remain certain lowered threshold characteristics on a number of neuron circuits, making it possible for further similar signals to pass faster and easier through the cortex of the brain. The surrounding circuits, in opposition, create the "barrier," or "borderline" with higher threshold characteristics. The same process concurs with the reflections from the parental lobe (and occasionally from other parts of the neocortex), containing the "esthetic acknowledgement," or

from subcortical regions ("esthetical feelings"). Thus the physiological faculty of recognizing esthetic value may be stored in the human memory. By repeated storages and retrievals of comparative information units, the recipient develops his "esthetic taste." Although such a development is hardly observable in normal human behaviour, significant differences are revealed by biometric scanning of individual responses to the perception of esthetic achievements or even mere reality. Esthetically trained readers read a text completely differently and may retrieve a different form and content of the textual messages than lay readers. A professor of art history observes other accents and qualities. in classical paintings than the gallery guard who is exposed to the same famous paintings throughout major periods of his life. The artist may retrieve from a masterpiece (his own or by other artists) stimulation of unexpected power and scope.

It should be noted that this "esthetic impact"(connected with repeated esthetic acknowledgement or feelings), may originate in one or all three major parts of the information chain: in the work itself; in the environment, where the art is intercepted; in the recipient (reader) and in his past experiences, memories or systems of thinking. Estheticians and art historians experience and respond critically to the esthetic impact produced by a given work of art; but they are less aware of the esthetic influence of the environment which, consequently, is much less explored and analyzed in their criticism.

The contrast between the work of art and the environment (the

frame of a painting, the darkened theatre auditorium, the silence before a concert) is the first major environmental influence. Its neurophysiological impact lies in the major change in the sensitivity of neuron circuits to the incoming information impact (labelled "anticipation"). The isolation of a work of art from environmental interference, e.g., noise, clears the sensory input. The art of typography and layout is based on this premise. Only in exceptional cases, is the interference welcomed. The work of art may be too dense, overpacked with information units, e.g., the surroundings of a TV set may be a welcome distraction. Or, in a gallery, peaceful glimpses of a garden relieve the fatigue of viewing too many paintings. In addition, one has to consider more than the immediate environment of any artistic achievement under scrutiny. The environment extended in space and time, and projected back into the piece of art also modifies our esthetic experience. The relevant factors of this type of environment include the viewer's perceptual, cultural and mental stereotypes and archetypes which influence his esthetic outlook and his specific esthetic responses. There are very well known attempts to program preceding and succeeding time or space segments framing the work of art. The sophisticated programming of space and time is observable in the churches, palaces or urban settlements known to most civilizations and cultures.

A peculiar situation occurs if we cross the time/space axis of the environment, for instance, when we exhibit Roman sculpture in 20th century buildings or read medieval books in a modern library, or hear

Renaissance music on the radio. In such cases, the environment may increase or decrease the original esthetic impact. The same situation may occur with the time axis when we present several views of a Roman temple via a few shots in a film or via a few photographs in a book. The recipient's esthetic education also can increase the impact produced by the work of art whose subtleties might otherwise remain unnoticed. However, this heightened response may also occur accidentally if the recipient has certain strong memories, attachment or sentiments related to the content or form of a specific work of art. In the past, such impulses may have led to the acquisition, theft or destruction of art treasures. In rare cases, "maniac attachment" may have its origin in exceptionally high esthetic feelings rather than esthetic impact or acknowledgement.

On the margin of these comments one may add that the elicited esthetic response oscillates considerably depending on the direct, substituted, or projected (deferred) transmission of the work of art. Reading a work in the original or in translation, seeing an original oil or its reproduction or hearing only a review on it triggers contrasting responses.

There are several auxiliary processes in the human brain which substantially influence, speed up, delay or change esthetical reactions: 1. The depth stress-wave: In certain cases of information input to the brain from the book being read, the stress-wave (emotion) may burst over several layers of the cortex and subcortical regions quickly and simultaneously (into hypothalamus or recticular formation). Reflection, in

this case in the upper cortical regions, may evoke a notion close to the term "beauty." This notion may cover various cases, only some of which may be related to esthetic feelings. Therefore the acknowledgment of beauty alone is not always esthetic, yet it may enhance esthetic feelings, acknowledgments or values.

2. The "overlapped overload": When information is coming into the cortical region, usually the brain works much faster than the input. Therefore, certain regions already have neuron circuits or a lowered sensitivity to the input, others may set "barriers." We call such processes "anticipation" or "forecasting" (of a story, event, process of esthetic perception). But if the author of a play or book uses an unexpected turn, situation, color or musical tune, the input falls into the wrong neuron circuits, causing high resistance, stress-waves, blocking of neural pathways. The brain re-adjusts quickly to follow new pathways. The remaining cortical or subcortical reflections of resistance are called "surprises."

Such a mechanism can be an important trigger to the conjunction of specific firing and stress-waves, together originating the esthetic impact of the piece. In this way, artists may reach the expected stimulation more easily than by the regular topical and stylistic techniques. Very important is the "after effect" of an overload. Surprise must be cooled-off, in order that the brain may resume the normal rhythm of information processing. Repeated surprises may cause an oscillating perceptual rhythm--which alone is a very powerful artistic tool--but ultimately lowers the recipient's sensitivity to

the content of the work of art.

3. The "imposed" information cascade: The artist and his work determine the recipient's perceptual process. By a subjective movie camera, by the text of a book, the author discovers with the viewer or reader the setting and the situation of a scene. Generally, the reader is disposed to "be privileged to be with the author, to flow with the show . . ." and model his own perceptual process as the author and his work dictate. The imposed cascade may sometimes cause psychic or attitudinal effects (e.g., Eisentein's rapid cinematic montage), where the viewer at least temporarily changes his own beliefs, values, esthetic judgments. But the effect of an imposed information cascade is of short duration; it ends a few minutes after the perception.

4. The "stimulator" impact here serves only as a minor initial input, usually of a formal nature, and the art lover follows the perception in loops, occasionally returning to the perceived work of art, but mostly performing his own mental variants of the theme and its forms. Many religious pictures and many abstract paintings provoke such a reaction. In poetry and music, where stimulators are extensively used, we distinguish programmed stimulators(such as music or poetry treating concrete subjects) and stimulator envelopes(such as disco music, dada poetry). In the first case, the higher cortical functions are in operation, in the second case, the cerebellum or only parts of the left brain's hemisphere, like the Wernicke Centrum are active.

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The neurocybernetic view of esthetics can be summed up as follows:

1. The notion of esthetics is a complex system of neural reflections within the cortex of the human brain. It may or may not need an external sensory input which serves either as a stimulator or delivers certain content, messages ranging from fragments of reality to the hierarchy of stereotypes and archetypes.

2. Esthetic impact has the characteristic of temporal neural pathways (similar to any "thought" or "idea"), but what is retained in the long-term memory of the cortex is not the pathway, but its by-product, the borderline resistance of surrounding areas. This resistance is not permanent, but changes more slowly than other neural pathways, and arises more slowly.

3. Esthetic response is not inborn and must be learned by human beings during repeated experiences, but such learning is very slow, difficult and, in many cases, impossible.

4. The process of esthetic impact varies significantly from person to person, across cultures and history.

5. The first level of reflection (lowest one) can be called "esthetic feeling"; the higher, more complicated, "esthetic acknowledgment or appreciation"; the most permanent and highest process can be called "esthetic value."

6. Besides the basic process of neural reflections in the human cortex of the brain, there are many other helping mechanisms involved in the esthetic experience. In this category, belong the notions of "beauty,"

"surprise", "anticipation" or "stimulation". Despite their different labels they work together neurophysiologically to support the basic "esthetic" reflective process.

III

Esthetic Information Profile of Literary Texts; Instrumentation and Methodology of Biocybernetic Assessments

The biometric follow-up of the cortical processes during and after the reading of a literary text, graphically or digitally represented, can be called the esthetic information profile of the literary text.

There are a few facts to consider before any diagnostic interpretation of biometric data can begin.

1. Cortical processes in the brain occur simultaneously in a large neuronic interference network. We can thus imagine it as a three-dimensional spacial field of activity. Biometric electrodes extract electrical potentials within two or more points of this field. Therefore, we are never able to register the full potential of the impact in a given time segment. But on the other hand, any potential extracted in this way is a document of a major process taking place in the cortex.

2. Let us stress that each profile biometrically extracted is highly specific to a particular reader and the particular time of the test. Any attempt to generalize on such findings by trivial arithmetic or social statistic methods appears to be absurd. There is no such notion in biometry as the "average reader" or the "median impact." Each reader must be treated as a unique individual with unique responses. We may

even extract different biometric profiles of the texts from the same person at different times.

This fact, although incompatible with exact sciences and statistics, corresponds to the well-known experience that the same book can be read with different levels of appreciation at different times.

3. The key prerequisite to the diagnosis of a biometric profile is a preliminary assessment of the reader's basic biometric parameters. This is called a pretest. It consists of a series of simple stimuli whose esthetic information impact is known. From responses to the pretest the instrumentation is adjusted to ensure that any further information impact is readable. Some people produce very faint responses: they may have a high impact in test-reading, while other stimulation cause only a mild impact. The pretest permits individual attention to the intensity of signals--a basis for possible reduction or enhancement of the subsequent biometric data, registered during a reading of the literary text.

4. Although most processes during and after the reading of a literary text occur in the cortical regions of the brain, their effects extend into the subcortical regions and to the peripheral neural system of the body. It is very difficult to reach regions deeper into the brain or processes beyond the speed of 1/80th of a second with existing biometric technology. It is much easier to reach such an impact indirectly (via ECG, GSR, BSR, EMG). But by registering such indirect responses, one

must be aware of time delays of different processes. Both may cloud the original cortical impact. Similar pre-tests are a must by such registration. Data from pre-tests are important co-readings, offering comparative data for further reading of a biometric profile.

5. There is little doubt that what we get in the esthetic information profile of literary text is only the primary information impact; the one arising during and shortly after the reading of the text. Any subsequent thoughts, imaginings, or psychodramatic processes are excluded and any biometric registration of such responses has not yet been developed. We must be aware that present technology enables us to detect only major energy changes, not the latent states. The most advanced instrumentation is oriented for the detection of electrical potentials, but from biocybernetic studies we know that the changes of electrical potentials in neuronal networks represent only a minor and minute phase. Chemical changes are much longer and much more significant but the technology of detection (chemospectography and radiospectrography) are still in the stage of initial development.

The tests designed to trace the responses to literary texts, require the following equipment:

1. Sensory tracking devices.

Their task is the primary visual tracking and the secondary aural tracking. For visual tracking, a variety of electro-oculographic devices are available on the market. The simplest are tachistoscopes, but they create uncomfortable dissection of the text, and there is substantial

fatigue involved by prolonged testing. The oculograph and electro-oculograph are more advanced machines and are commonly known as eye-movement machines. Probably one should say here that the machine with precise paper registration or digital data storage is better for our purposes than those involving registration via a photographic or videotape mode.

The most suitable are combinations of electro-oculographs with electro-retinographs when the response of the direction (eye movement) is intercorrelated with retinal response. Such apparatus offers a real information impact measure, detected in the very moment when visual stimuli begin to work in the reader's body.

For detailed analysis of literary texts, this device may be connected with an x-y-plotter so that detection of reading may be done up to the detail of a single syllable or even letter.

For research experimentation here, a machine type Eye-trac, Mark IV, adjusted for ERG reading with x-y plotter and alternate digital processing output to the PDP 11/25 computer disc memory storage is a most feasible combination.

2. Cortical response processing device.

For extraction of cortical data responses, a clinical EEG (electroencephalograph) is used with appropriate graphical/digital registration output. Generally, 10 electrodes are used simultaneously with the majority in the left hemisphere (Wernicke, Brocca centres), with control electrodes on the cerebellum and in the parental lobes. In most cases, silver/silver-chloride electrodes give satisfactory results. In some cases (abundant hair), barium/lithium electrodes are better, but

give out a lot of unwanted noise due to the high sensitivity. There is really no necessity to run separate multitrack EEG, if careful multiplexing of signals is used.

So far the best results were obtained by a five-track EEG with SSCH and Harrison BL electrodes.

3. Peripheral responses processing device.

These instruments include ECG (Electrocardiograph), GSR (Galvanic skin response), occasionally, BSR (Basal skin response) and EMG (Electromyograph). The major importance of peripheral apparatus is providing control channels. ECG is effective mainly in the subcortical reflexes to the changes of osmotic blood pressure. As such it confirms the stress-wave process in the cortex usually associated with the reflection of emotions. GSR channel is one of the controls with a very slow, but vivid reaction to the major attitudinal, contentual characteristics of the text. BSR channel has its value in specifi reactions very often associated with poetic texts and the EMG channel processes responses to the style of the text.

It is very useful to run peripheral channels in close timing with others, possible on multi-channel polygraph or digital processor, so the verifying procedure is simplified.

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The technology of the biometric techniques developed to trace the reader's esthetic responses to literary texts is quite recent. The method of exploring the intensity of the physiological reactions referred to as esthetic delectation or esthetic surprise is still in the experimental stage. It can be considered a pilot for a more refined and sophisticated method which may ultimately be developed to elucidate all details of our esthetic perception. Here is a description of the present method used in the following steps:

1. Selection and preparation of test subjects.

   a) The proposed test subject should agree voluntarily to undertake the test measurements and sign the release at least a week before the first test.

   b) A brief interview and medical check-up offers preliminary information on the subjects being considered. The pathological and retarded cases are excluded. (All material is kept in confidential files.)

   c) The aim of research, method of research and instrumentation of test is explained thoroughly to each person, so that possible fear of the laboratory environment does not affect the subject's esthetic responses. The subjects so affected should be excluded from testing.

2. Pretests of Subjects. The preparation for the biometric tests is preceded by extensive control pretesting. This stage includes the

following operations:

a) Input pretest. For each input channel, following pretest should be made: range intensity, range contrast, range field. The ranges of visual or audio perception should be aligned with the ranges of the input instrument record. The zero stage should be aligned with no-input state.

b) Processing pretest. For EEC and EKG channel, range of recording should be aligned with basic binar response of subject (open-close for visual, sound-no-sound for audio). For GSR and EMG channel the verbal direction to desired or non-desired state should be aligned with range of recording.

For both these pretests several repetitions within a close time range are necessary. The reading should be identical on at least three following recordings.

3. Pretests of equipment.

a) Technical pretesting. Each machine is first separately wired, adjusted and attuned to the test subject. Then the apparatus are inter-correlated to each other (sensitivity, range, attenuation) and to the tested person. No text is used during the pretest period, only an empty card, range, places where the text will appear.

b) Programmed pretesting. A short sample of literary text not to be applied in the subsequent tests is used (2-3 sentences) in the same typography and same language to assure that the system

is working properly. The results of the technical test are immediately compared with the recording and necessary re-adjustments are made. After that, the first major test should be run no later than forty seconds afterwards.

As the pretesting belongs to the general preparation of all subsequent tests, it should be performed immediately before the test runs. It is intended to delineate the sensory field, reaction time, processing abilities of the subject, search abilities, storage occurrencies. What plays the major role in the diagnosis, is not the isolate curve or fixation, but rather the envelope curve.

4. The tests, their phases and modifications.

a) General readability test. This is a straight multi-channel biometric test run where the tested person reads the text segment at his own pace. No conditioning or adjustments are made from the pretest period. A short diagnosis follows afterwards and very soon the Decision/Selection test is run.
This test is aimed to the general information input, processing and storage. Envelope curves are most important indicators, as well as high amplitude areas and dense excitation peak areas.

b) Decision/selection test. This reading is limited only to those parts of the text where profound reactions were extracted during the general readability test. The reason is to detach the cumulative impact of the information test cascade from the impact of the information domains.

This test consists of high-speed sectional test run of the part of the general readability test where either high excitation or dense high amplitude excitation occurred. The diagnosis of the test should reveal the structure and characteristic of information domain. It could also reveal the direct or cumulative impact within the information cascade. Besides these two basic tests, a number of specific testing can be made with emphasis either on media carrier (print, typography, illustrations) or on individual biometric channels (emotional impact, reactivity, content impact, etc.).

c) Basic media tests (colour, movement, shape). Each of these tests consist of comparative reading of input channel plotted towards a specific characteristics of stimuli (texts, illustrations). The occurrences within the basic media become visible, when specific plotted information part is changed, or parameters of input are changed. The registration received is compared with the general readability test.

d) General processing test. In this test multi-channel biometric tracking is used, with EEC channel in basic operation, and sensory tracking (ev. EKG), as supplementary time log tracks. EEC channel is then leading in diagnosis. If only binary decision are sought, the event recorded is plugged on EEC channel.

e) Stress-wave test. In this test we are searching for stress-wave development during the processing of information. It consists of sensory input tracking (plotting), EEC channel and in time synchron the EKG channel, with electrodes following the small circulation circuit, grounded on chest. The stress-wave becomes immediately visible on EKG channel, within the 1-2 second range from input. The intensity of recording will vary from person to person. The length of impact could cease within few seconds, or could have characteristics of rhythmical prolonged duration (bouncing wave).

f) Reaction test. There are three kinds of reaction tests: general (positive-negative, with zero in the centre of registration), negative (resistance test), and positive (action test). General reaction test consistsof GSR channel as leading one, with sensory tracking and EEC as complementary channel. Negative (resistance) test is done with combination of GSR and EEC channels. Positive (action) test is done with GSR as leading channel and multiplexing of EEC and EKG for precise time log. In all the reaction tests, the pre-test revealing the person's reaction attitude is often the key to the diagnosis. In the case of different subjects, the GSR peaks could be triggered by different stimuli. In all cases, EEC record should be consulted before any conclusion is drawn.

General Remarks on the Specific Tests, Their Techniques and Their Overall Process:

First test run: Within short span of time, following both pretest (approximately two minutes), the first run of test collection should be made, on multiple channel recordings. Test run should contain also the time span between the stimuli exhibition with overlaps or incidental processing.

Oral check-up: Right after the first test run, a short oral check-up should be made, with reference to the registered reactions. Most of the question should be geared to the parts of the test run, where either non-aligned recordings occurred, or where a significant reaction was obtained. The reason for oral check-up is to eliminate possible side-effects (motoric reactions, metabolic reactions, etc.) non-related to the exhibited stimuli.

Second test run: Approximately 10 minutes after the previous stage, both the two pretests and the test itself are repeated. During the second test, the instrumentation should be aligned as close as possible to the parameters of the first test. All differences should be marked on pretest (adjustment of potentiometers, follow-up of samples). Special attention during the second test should be devoted to the areas of high reactions (information domains), and in this case a high speed of recording should be adjusted.

Marking stage: Following the completion of the test, the researcher should reveal the test results to the examined subjects and interview them to check on the test results. The goal of this interview is the detection of the accidental results (instrumentation or operational mistakes); at this stage the areas of high-intensity results should be marked by envelope curves. Slide rules should be used for alignment of time log for channel interactions.

5. Interpretation of data recorded In trying to reach a legitimate diagnosis the biometric researcher generally adheres to the following empirical practices applicable to the input area (A) and to the storage area (B).

A - Input Area.

a) General activity characteristics. When looking on eye-trac or audiospectrographic (phonographic) recording, the overall activity pattern should be easily visible. In both cases, the quantity of fixations give us an indication of quantitative level of information input.

b) Information domain characteristic. Whenever a period of dense, short fixations occurs, accumulating within a few seconds' range many fixations, and when this period is followed by long but sharply distinguished fixations, there is high probability of information-domain interception. Such an occurrence could be easily checked by X-Y plotting of image or reading of notation (in musical score).

c) Input storage periods. There are visible marks on each input recording, when the activity of sensor is temporarily decreased for short time, periodically. In visual tracking, this could correspond with muscular activity of eye (blinking for example), but is not necessarily dependent on physical activities of the

eye. The sign has a typical V characteristic of varying amplitude. The slip should always have more than 30^{o} angle and should not be delayed for more than 2/10 of a second. It is on the lower border of persistence of vision (1/6 of a second). In audio tracking, the slip could last even longer. Input storage periods signify the renewal of optical (visual) reading periods, whence the sensor departs on new and different pattern of interception.

d) Basic media characteristics. Intensity, contrast, colour and movement are basic media, intercepted by eye. Each of these leave a distinctive pattern on the biometric record. Intensity is related to the amplitude of recording, contrast to the length of fixations. Colours produce the various lengths of fixations (shorter wave lengths, shorter orange, red; longer wave lengths, longer blue. The longest fixations are produced by the wave length around 500-560 mmc, yellow-green area). Movement produces the distinctive marks of slips on recording. The more fluent the slip, the faster the movement inside the image or the image itself.

B - Storage Area

While working with a system (brain neocortex) which is in a relative state of constant activity, we must distinguish the bio-perceptual rhythmical patterns from processing, storage and search patterns; the metabolical patterns from specific neural circuitry patterns, and specific excitations on part of neocortex from stress-wave excitations.

a) General activity characteristics. When looking at multi-channel recording, the overall activity pattern is visible in variations of amplitudes, differing sharply from rhythmical bioperceptual patterns, which could be aligned with short time distance (to 1.5 sec.) with input perceptual stimuli. The activity points could have varying amplitudes and varying duration times, could be overlapped or could cease the activity pattern, not depending on the duration of initial stimuli.

b) Storage pattern. Storage pattern could be spotted on multi-channel recording (mostly on EEC channel), with characteristic triangle recording. After initial excitation, the amplitude diminishes gradually, ending on a different recording from biological rhythm, and similar to the initial excitation record. When high speed is used, the slow change from stored to the biological-rhythm information processing (biochemical chain) can also be spotted.

c) Search pattern. When several high excitation peaks occur within the range of 0.5-1.6 seconds,it is a high probability that an intensive search is happening within a close range in the neocortex. The search may or may not result in the storage pattern. In most of these cases, the bio-rhythm after the search shows distinctive change, whether or not any storage results.

d) Stress-wave pattern. There are two basic kinds of stress-wave indications: on EEC channel, it is a gradually increasing

Interpretation of biometric recording is not easy. The results registered in the graphical or digital record are, in fact, a mechanical quantification of a dynamic biological process. Thus one has to realize that any change of biometric potential (spike) may mean very little in the overall diagnostic decision. What is more indicative is the "envelope curves" of activities and specific patterns of activities. The individual high amplitude spikes may not be significant--unless they occur periodically.

The search for specific patterns should start in the pretest of the subject. Slight irregularities, delays in reactions to stimuli, or asymetric registration (of symetric stimuli) may later determine the specificity of the pattern. The processing any memory patterns are not visible on an EEC, nor are the reaction excitation patterns on an ECG, and on a GSR. Furthermore, their shapes and durations differ from reader to reader.

A special kind of pattern gives an inter-channel comparative pattern, which is closest to what we may call the origin of esthetic information impact. But its recognition and diagnosis depend on a careful comparison with the pretests of the person, control channels and the tests alone.

amplitude within range of a second, creating a vivid, triangle-shape signal. The end of the triangle usually ends in longer activity at high amplitude. The second indication is usually visible on EKG channel: it is a high variation of the envelope curve (excluding the spikes of bio-rhythm at EKG). These two variants (EEC and EKG) have specific co-incidence: if EKG precedes in stress wave EEC, subjects are inclined to cause the rational thinking as a beginning of stress wave state.

In both areas above (input and processing), the decline of activity or decrease of neural functions (fatigue) could be similar. The differences could be discovered either by increasing the amplification of the signal or by increasing the speed of recording. In the first case, the biological rhythm will produce a large periodic pattern; in the second case, the shape of signal will be repeated with great similarities.

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